tion, the growth of plants, and other important effects) depends mostly upon the distribution of cloudiness.

Cloudiness.—The number of clear and cloudy days and the average cloudiness between sunrise and sunset are given for each Weather Bureau station in Table I. These means are based upon personal observations made during the day sufficiently often to secure a correct average cloudiness. The complements of the estimated percentages give the observer's estimated duration of sunshine, and these numbers are given in the last column of Table IV as supplementary to the registered duration, in the preceding column. The close accord of these numbers, in most cases, is very satisfactory.

The occasional large discordance between the monthly sunshine as estimated by the observers and as registered by the instruments shows how impossible it is for personal estimates to compete with continuous self-registers.

Sunshine.—At the present time an instrumental record of the amount of sunshine is kept at 15 stations by means of the "photographic sunshine recorder," and at 19 stations an equivalent record is kept by means of the "thermographic sunshine recorder." A description of these instruments and the method of dealing with the record is given on a subsequent page. The results of the observations for January, 1894, are given in Table IV. This table shows the actual sunshine received, on the average, for any hour of local mean time during the month; it is recorded as a percentage of the greatest possible amount of sunshine; for instance, the sun might possibly always shine during the whole hour ending at 1 p. m., whereas, at Baltimore, Md., it has, on the average, been cloudy 32 per cent of this hour, so that only 68 per cent of full sunshine has been received. Again, at the time of sunrise, between 7 and 8 a. m., during January, Baltimore records 13 per cent of sunshine, which means not 13 per cent of the thirty-one whole hours between 7 and 8 a. m., but 13 per cent of that portion of these hours during which the sun was above the visible horizon of that station; the remaining 87 per cent was cut off by clouds and fog. On the average both kinds of self-registers agree in giving 5.5 per cent more sunshine than the personal estimates by the observer.

The stations recording the largest percentage of sunshine between 11 a. m. and 1 p. m. are Colorado Springs, Colo., 83.5; Denver, Colo., 82.5; Key West, Fla., 81; San Diego, Cal., 89; Santa Fe, N. Mex., 83.5. Those having the least are Cleveland, Ohio, 39; Portland, Oreg., 23.5; Galveston, Tex., 41.5.

The next to the last column of Table IV gives the general average sunshine for the whole month for all hours of daylight; the highest percentages are San Diego, Cal., 84; Santa Fe, N. Mex., 79. The lowest averages are Portland, Oreg., 19; Cleveland, Ohio, 33; Buffalo, N. Y., 36; Galveston, Tex., 40. The low average for Portland, Oreg., is, of course, in keeping with the cloudiness of its rainy season.

NOTES BY THE EDITOR.

ELASTIC SUSPENSION FOR INSTRUMENTS.

Over fifty years ago Prof. G. B. Airy, Director of the Royal Observatory at Greenwich, desired to establish a shallow dish of mercury so that the pure reflecting surface of the liquid could be used for astronomical observations without being subject to the annoying tremors that ran over this surface whenever wagons, railroad trains, or even human footsteps jarred the earth around the pier on which it stood. He achieved perfect success by suspending the dish of mercury by a number of elastic springs. No matter how much the pier and, therefore, the upper ends of these springs were jarred, the minute vibrations did not run down through the springs to the basin of mercury, but were completely broken up on their way. In 1889 the present editor desired to support the Richard barograph on the U. S. S. *Pensacola* in such a manner that it should be free from all the effects of the jarring due to the engines and screw as well as from the effects of the rolling and pitching of the vessel. This again was accomplished perfectly by setting the instrument on a small shelf that hung suspended by long coiled springs at the four corners.

The "Washington State Weather Reporter," published by the State Weather Service at Seattle, describes the application of this principle to the suspension of maximum and minimum thermometers. Prof. L. P. Venen, of Vashon College, is the inventor of this method, which is described as follows: A rather heavy block of wood is suspended by a thick spiral spring from the ceiling of the ordinary thermometer shelter; one or more elastic cords are stretched from the block to the sides of the shelter, and thus keep the block from swinging with the wind; the maximum and minimum and other thermometers are fastened on the block and can, therefore, receive no violent, injurious shock from the outside; they are even safe from the slight jars due to the wind or other influences by means of which the index of the minimum thermometer is very apt to slip down too low.

Doubtless other applications of this method of elastic suspension will occur to meteorological observers. Its principle is, of course, the same as the application of springs to the axles of carriages and railroad cars, or of rubber tires to the wheels of cabs and bicycles.

THE RELIABILITY OF THE RAIN GAUGE.

In the winter season observers frequently report that the wind has blown too severely during a snowstorm to allow of accurate measurement; by this we are to understand one of two things, either the snow has been drifted so much that the observer can not make a satisfactory estimate of its average depth over the country in his neighborhood, or else that he has observed the wind carrying the snow past his gauge to such an extent that he can not consider the amount caught in his gauge as a fair indication of what fell, or of what would have been caught if there had been no wind. This phenomenon of drift and this deficiency in the catch of the rain gauge are matters that trouble not only the measurement of snow but of rainfall on all occasions; the rain gauge is subject to a very appreciable error, which has always the nature of a deficit, and which increases with the strength of the wind and the fineness of the rain. It seems a very simple matter to determine the quantity of rainfall by setting a simple cylinder or a pail or tub out in the open field and measuring the depth of water that falls therein. But if the gauge is in an open place fully exposed to every wind it will catch less rain than if it is artificially sheltered from the wind while standing in the same spot; if, on the other hand, the gauge is moved to a sheltered spot, it is liable to catch an erroneous rainfall, sometimes larger and sometimes smaller, depending on the location and heights of the buildings that shelter the spot. The true problem of the meteorological observer is to put his gauge in an open place, free from the influence of all buildings and trees, and yet determine the true rainfall at that spot free from the influence of the eddies produced by the wind at the mouth of his gauge. There is probably no error in the catch when it rains during a calm, but if the wind is blowing while the rain or snow is falling, then the gauge itself acts as an obstacle to the wind; the air that flows around it and above it, but close to it, moves faster than that a foot away from it; the snow flakes and finer particles of water that go into the gauge in one eddy come out on another. Some means must be devised to break up all eddies at the mouth of the gauge, or, failing that, we must have some method of applying a numerical correction.

Several instrumental methods have been adopted for preventing or diminishing the wind effect: *First*, about 1853, or earlier, Prof. Joseph Henry recommended to the Smithsonian observers a shielded gauge which is simply an ordinary cylindrical gauge having a horizontal, circular plate of tin 4 or 5 inches wide soldered to it an inch below the mouth of the gauge. By this means the disturbing eddies are kept principally beneath the flat rim, and, therefore, do no harm at the mouth of the gauge. *Second*, in 1878 Prof. Nipher, of St. Louis, described his form of shielded gauge in which the tin plate is replaced by an umbelliform screen made of wire gauze; the gauze sufficiently breaks up the wind eddies while it greatly diminishes the spattering. Nipher's experiment showed that gauges at the height of 118 feet above the ground caught nearly the same as those at the ground. *Third*, in 1885 Boernstein devised a protected gauge, which is an ordinary gauge surrounded at a distance of a few feet by a separate fence or screen whose top may be a little above the top of the gauge; this protecting fence, therefore, diminishes the wind at the mouth of the gauge without introducing new and injurious eddies. Roofs of buildings are occasionally built slanting inwards instead of outwards, or sometimes the walls of the buildings rise several feet above the surface of the roof; in such cases a gauge placed near the center of the roof is protected against the violence of the wind and catches more than it would if raised a few feet higher above this protection. *Fourth*, the so-called pit gauge as first used in England; in this method a shallow pit is dug, from 3 to 6 feet in diameter, in the midst of an open field, and the gauge is set in the center so that its mouth shall be on a level with the surrounding field while the spatter is diminished in proportion to the depth of the pit.

As the wind increases rapidly with the elevation above the ground, therefore, gauges placed at great heights will catch less rain or snow than those at low elevations. The amount of this deficit is known quite accurately from many years of observations, a summary of which has been published by the present editor in Bulletin No. 7, Forestry Division, U. S. Department of Agriculture, pp. 175-186, from which the following table is taken:

Group.	No. of stations.	Altitude.		Observed deficit.
		Meters.	Yards.	
				Per cent.
1	4	0	0	0
2	4	1	1	10
3	4	2	2	12
4	4	3	3	14
5	4	4	4	15
6	4	5	6	15
7	4	6	7	16
8	7	13	14	21
9	7	28	31	36
10	5	59	65	42

In this table the pit gauge, at an altitude of 0, is adopted as the normal with which the gauges at other altitudes are to be compared. The table, for instance, shows that on the average of five stations at an average altitude of 59 meters, or 65 yards, the upper gauges caught only 58 per cent of that caught by the normal pit gauge, that is to say there was a deficit of 42 per cent of the normal rainfall. The deficits here given relate to the average snow and fine rain of winter and heavy rain of summer, and the average wind velocities at various European stations during several years. The deficits given in the fifth column are well represented by the expression: "Deficit equals 6 per cent of the square root of the altitude expressed in meters or yards;" but this 6 per cent is a factor that must vary with the character of the precipitation and the wind, being much greater in light rains and snows and much smaller in heavy rains.

If we establish two smaller gauges in an open field so that the mouth of the upper is twice as high as that of the lower, then the corrected rainfall will be found by adding to the catch of the lower gauge 2.414 times the excess of the catch of the lower gauge over and above the catch of the upper gauge. The value of any long series of rainfall measures will be greatly increased if the observer will establish near the present rain gauge another one of the normal styles known as the pit gauge, or the shielded gauge, or the protected gauge, or, failing that, if he will establish a second gauge similar to the one that has been long in use, but at twice its height above the ground or the roof. The comparison of the two records at the end of the year will give some idea of the irregularities to which the earlier records may be liable, and will show to what extent the records may be relied upon in discussing the question of a change of climate.

PREDICTION OF SEASONAL SNOW AND RAIN.

Mr. S. V. Rehart, of Lake View, Oreg. (N. 42° 05′, W. 120° 20′; altitude about 5,000 feet), writes under date of February 5, 1894, as follows:

"Several years ago I observed a peculiar weather phenomenon which at the time I regarded as a mere coincidence entitled to no consideration, however, after having observed many repetitions of the same I believe that there are good grounds for the conclusion that said phenomenon is an indication and criterion that will enable us, months in advance, to predicate approximately the amount of precipitation that will be experienced during the winter season.

During the past twenty years on the Pacific coast the precipitation has been proportionate to the amount of heat during the previous summer; every winter of excessive precipitation was preceded by a long heated period during the summer, and every winter of light precipitation was preceded by a cool or cold summer as commonly understood. It is my opinion that all the precipitation on the Pacific coast originates over, and is governed by the Pacific Ocean; consequently, other regions would be governed by the same law. In describing some of the extreme seasons of the past, which the foregoing statements are based upon, having no data, I shall necessarily have to rely upon memory for the same, moreover the observations were made without the aid of instruments, in a high altitude, and over one hundred miles from the Pacific Ocean; however, I confidently believe that a critical examination will practically verify every statement herein made.

1874.—The summer of 1874 was an extremely cool summer, followed by light precipitation during the winter of 1874-'75.

1875.—The summer of 1875 was an extremely long, hot summer followed by excessive precipitation during the winter, corresponding in intensity and duration to the heated period of the previous summer.

1877.—Passing over one year brings us to the summer of 1877, when cool weather prevailed until July 10, when an excessively heated period began, continuing between five and six weeks, when unusually cool weather began and prevailed during the autumn months.

During the following winter all the early storms were only partially successful and only light precipitation prevailed until January 10, 1878, when excessive precipitation began, continuing between five and six weeks and ending abruptly, after which exceptionally light precipitation prevailed during the spring months.

1878.—The summer of 1878 was another extremely cool summer followed by extremely light precipitation during the winter. This year remains vivid in my memory from the fact of a successful business venture made by myself, involving one-half of my capital stock; said venture being entered into upon the belief that light precipitation would be experienced during the winter of 1877-'78.

1889.—Passing over several years we come to the summer of 1889 which was a long, hot summer followed by excessive precipitation during the winter.

1890.—Cool weather prevailed during the greater part of the summer, the heated period being of short duration, and during the winter less than an average precipitation was experienced.

1891.—Cool weather prevailed all summer, excepting the month of August, when rather excessively hot weather prevailed during the month.

The following winter light precipitation prevailed, excepting the month of December, when successful storms were experienced during the whole of said month.

1892.—The summer of 1892 a long period of hot weather prevailed, although the heat was less intense than some preceding summers described.

During the winter the storms were all more or less successful, and precipitation considerably above the average was experienced.

1893.—The summer of 1893 had a heated period lasting about two months, beginning July 1 and ending September 3, when exceptionally cool weather began and continued during the autumn months (similar to the autumn of 1877).

While the heated period was longer than an average of summers, the heat was not excessive, excepting a short spell in the first and latter part of the heated period, consequently, there was less than an average amount of heat during the past summer, everything considered, and consequently, I have been expecting less than an average precipitation during the winter, and in all probability, exceptionally light precipitation during the latter part of the winter and early spring months."

NOTE.—The observations quoted by this observer as the basis for his generalizations seem to have been made at or near Lake View, on the southern-central border of Oregon. This station is at the northern end of Goose Lake, a body of fresh water about 30 miles long north and south and 10 miles wide, whose outlet at the southern end is the Pitt River, flowing into the Sacramento. This lake is, therefore, near the summit, but still on the western slope of the northern Rocky Mountain plateau region, and the precipitation at Lake View must result principally from the south and west winds that sweep up the lake and the valley of the Pitt River. As there is no Weather Bureau station of similar exposure in this neighborhood whose records can be appealed to to support Mr. Rehart's rule, the editor has examined the tables of temperature and precipitation at some stations in Oregon and Washington, given in the large mass of data that is summarized in the special report of the Chief Signal Officer, published as Senate Ex. Docs., Nos. 91 and 282, 50th Congress, 1st session, Washington, 1889.

The monthly temperatures and precipitations for 23 stations in Oregon between the years 1853-1886 were brought under examination; fragmentary years and very short series were omitted. The average temperature of the summer months during June, July, and August, and the total precipitation during the following winter months, December, January, and February, were computed. Each summer temperature and winter precipitation was marked A, N, or B, according as it was above the normal, normal, or below the normal; there were of temperatures 52 A, 83 N, 49 B, and of rainfalls 51 A, 89 N, 44 B, or in all 368 seasonal numbers. The series was then examined to see how many times the winter precipitations, A, N, or B, followed the summer temperatures, A, N, or B, respectively. When precipitation above the normal follows a temperature above the normal, that is to say, when, for any given summer we have the sequence AA, or *vice versa* the sequence BB, then such cases are favorable to the rule of Mr. Rehart; there were 15 of the first out of the 52 A, and 8 of the second out of the 49 B, or 23 altogether out of 101 cases. When we have the sequence AB or BA, we have cases decidedly opposed to Mr. Rehart's rule; there were 13 of the first out of the 52 A, and 17 of the second out of the 49 B, or 30 altogether out of 101 cases. The cases of normal temperature or precipitation were, of course, the most numerous and do not so seriously affect the working of this rule; they were as follows: A N, 24; B N, 24; N A, 19; N N, 41; N B, 23, or in all 131. Classified by years, the only year for which a relatively large number of stations gave results decidedly favorable to the rule was 1886, for which there were 5 favorable stations and 6 neutral. We must conclude, therefore, that this rule does not hold good for the whole Pacific coast, nor for the whole of Oregon, but only for some particular locality, if at all.

It is very desirable to investigate all plausible empirical rules in climatology, but it is, of course, absolutely necessary that such study should be based upon observations recorded at the time and made accessible by publication to those who desire to study the subject further. Possibly some modification of the rule here enunciated as to summer temperatures and winter rains may accord more nearly with the meteorological records.